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ILLINOIS
ENVIRONMENTAL PROTECTION AGENCY

LAKE MICHIGAN WATER QUALITY REPORT

1976

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Illinois Environmental Protection Agency

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The Honorable James. R. Thompson
Governor, State of Illinois

Honorable Members of the Illinois
General Assembly

This report is a summary of Lake Michigan water quality data collected by the Agency during 1976. Most water quality parameters tested remained within standards except for ammonia and phosphorus. These two parameters show a long history of standards violations that can in part be attributed to past and current wastewater discharges. Their levels will decrease as these discharges are diverted from the lake.

The most serious quality problem continues to be the excessive levels of Polychlorinated Biphenyls (PCBs) in most Coho Salmon and Lake Trout. Warnings have been issued that persons should consume no more than one half pound of these salmon or trout per week. Monitoring over the past several years has shown no downward trend in these levels in spite of our and other adjoining states' efforts to eliminate PCB discharges. High PCB levels are likely to continue for many years due to the extreme resistance of PCB material to degradation and because of present accumulations in lake sediments and fish.

This Agency will continue to emphasize protection and wise use of this valuable natural resource through our own programs and by cooperating with other State and Federal groups also working on a better understanding of the lake environment.

Sincerely,

Leo M. Eisel
Director

LME:RB:mjl:W7

2200 Churchill Road, Springfield, Illinois 62706

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STATE OF ILLINOIS
ENVIRONMENTAL PROTECTION AGENCY

LAKE MICHIGAN WATER QUALITY REPORT

1976

by

ROBERT A. SCHACHT and WALLACE O. MATSUNAGA

April 1977

WATER QUALITY EVALUATION, 1976

In 1976 most water quality parameters tested remained within state standards with the exception of ammonia and phosphorus.

A tabulation of a number of water quality parameters is presented in column form including beach and water filtration plant annual average values together with a standard or guideline. A number of standards are listed and footnoted to give a general comparison and may not apply to both beach and water plant samples for other than comparison purposes. In specific cases the text should be consulted for other parameters and additional information.

WATER QUALITY EVALUATION, 1976

Parameter	Standard or Guideline	Annual Average Beaches	Annual Average Water Plants
Turbidity	1.0 TU(e)	20.	6.
pH	7.0-9.0 units(a)	8.4	8.4 (h)
Ammonia(N)	0.02 mg/l (a)	0.09	0.06
Chloride	12. mg/l (a)	9.	9.
Cyanide	0.025 mg/l (b)	(1/180)g	(0/59)g
Fluoride	1.4 mg/l (b)	0.2	0.2
Phenols	0.1 mg/l (b)	(12/362)g	(1/119)g
Sulfates	24. mg/l (a)	21.	21.
Phosphorus (P)	0.007 mg/l (a)	0.07	0.05
Total Solids (Dissolved)	180. mg/l (a)	169.	168.
Fecal Coliform	20./100 ml (a)(d)	12.	3.
Nitrate + Nitrite	11. mg/l (c)	0.2	0.3
Alkalinity	100.120.mg/l (f)	107.	108.
Iron (total)	1.0 mg/l(b)	0.3	0.1
Lead	0.1 mg/l(b)	0.01	0.01
Manganese	1.0 mg/l(b)	0.02	0.01
Hardness	270 mg/l (f)	130.	130.
Color	15. mg/l (e)	2.	2.
COD	None	12.	10.

(a) Lake Michigan Standard - ¶206 Water Pollution Regulations, Chapter 3.
(b) General Standard - ¶203 Water Pollution Regulations, Chapter 3.
(c) Public and Food Processing Water Supply - ¶204 Water Pollution Regulations, Chapter 3.
(d) Based on a minimum of five samples taken over not more than a 30-day period, fecal coliforms shall not exceed a geometric mean of 20 per 100 ml.
(e) Finished Water Quality - ¶304 Public Water Supplies, Chapter 6.
(f) (McKee and Wolf, 1971). See Text
(g) Data is represented as the number of positive samples found (numerator) in the total number of samples analyzed (denominator).
(h) Median.

ACKNOWLEDGEMENTS

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WATER QUALITY MONITORING

BEACH AND WATER PLANT SAMPLING

Lake Michigan serves a broad spectrum of purposes. It is the source of drinking water for 5 million residents of northeastern Illinois. Its recreational opportunities attract fishing, boating, swimming and other water-oriented interests. It is the avenue for domestic and international waterborne commerce. Its readily available water for industry and commerce encouraged the growth and development of the greater Chicago metropolitan area into one of the largest industrial-commercial complexes in the United States. Ironically, Lake Michigan has also been the recipient of municipal and industrial wastes throughout its watershed.

Discharges from industrial complexes located along the southwestern shore of Lake Michigan affect the quality of Illinois waters. These discharges, consisting of process, cooling, dilution and other waste waters, have adverse effects on the local environment as well as the total ecology of the lake. Inadequately treated sewage effluents, bypasses from overloaded sewage treatment facilities and combined sewer overflows contribute to the lake's organic enrichment. The aging or eutrophication of Lake Michigan is accelerated by the addition of nutrients from both industrial and municipal discharges. While the number of discharges in Illinois are few and have little impact on the overall quality of Lake Michigan, local problems have resulted.

In addition to man-made inputs to Lake Michigan, lake water quality is also affected by natural phenomena. During most of the year, from about April to November, the lake is thermally stratified. The formation of thermoclines during this period prevents the free exchange of dissolved oxygen between these layers and results in the reduction of dissolved oxygen near the lake bottom. Stratification is destroyed during late fall and spring overturns. Mixing occurs between the surface and bottom waters during these overturns resulting in some resuspension of settled bottom deposits. At these times, there are noticeable and measurable increases in turbidity, color and mineral concentrations.

Lake currents influence water quality by distributing polluted discharges. Effluents may be carried a considerable distance from the point of discharge through physical transport or may remain near the point of discharge depending on the currents. In the areas affected by a pollutional discharge, sludge-like deposits may accumulate on the lake bottom affecting aquatic life. Organisms tolerant to the altered habitats will remain while the more sensitive forms either migrate out of the area of influence or die. In extreme cases no life survives. Tributary streams and rivers add to the sediment and nutrient levels of the lake. As these waters flow downstream, sediments, nutrients, fertilizers, pesticides and other substances are acquired through erosion, land runoff, and from industrial and municipal waste discharges. There are no major tributaries to Lake Michigan in Illinois.

Climatic factors, too, exert their influence on lake water quality. Increases in bacteria counts, suspended and dissolved solids and organic and nutrient levels can be expected following a storm and resulting storm water runoff.

Recognizing the importance of Lake Michigan as a natural asset, the 75th Illinois General Assembly authorized the Environmental Protection Agency to ".... regularly conduct water quality and lake bed surveys to evaluate the ecology and the quality of water in Lake Michigan." Pursuant to this mandate the State of Illinois conducts an ongoing program of water quality monitoring in Lake Michigan.

The monitoring program has provided information on the condition of the Illinois waters of Lake Michigan. As data are gathered on a continuing basis, it should be possible to determine long-term trends in lake water quality.

Lake water quality has been evaluated on the basis of the water quality standards promulgated by the Illinois Pollution Control Board. Three categories of standards are in force in Illinois depending on the use(s) to be made of the particular body of water. The General Standards are designed to "....... protect the State's water for aquatic life, agricultural use, primary and secondary contact use, and most industrial uses, and ensure the aesthetic quality of the State's aquatic environment." Waters used as sources of potable water and for food processing must, in addition to meeting the General Standards, meet the more stringent Public and Food Processing Water Supply Standards. Additionally, critical parameters were designated as part of the Lake Michigan Standards. Lake waters, in addition to meeting the General and Public and Food Processing Water Supply Standards, must meet the strict standards for:

- pH
- Ammonia Nitrogen
- Chloride
- Sulfate
- Phosphorus
- Total Dissolved Solids
- Fecal Coliform
- Temperature

In this report the shore and offshore data were evaluated on the basis of the Lake Michigan Standards for the above parameters. Standards applicable to the Public and Food Processing Water Supply were used to evaluate those offshore parameters not specifically covered by the Lake Michigan standard. Shore water quality, which is adversely affected by waste discharges, land runoff, and storms to a much greater extent than offshore water, was evaluated on the basis of the General Standards for those parameters not part of the Lake Michigan Standards.

Data on lake water quality were obtained from beaches and municipal water filtration plants. All samples were delivered to the Chicago Laboratory of the Illinois Environmental Protection Agency within six hours of collection. The cyanide, phenol, and metals samples were treated with preservatives to retard any chemical or biological alteration prior to analysis. Samples for bacterial analysis were collected in sterilized bottles and put on ice prior to delivery to the laboratory. Radioactivity samples were acidified and sent to the Champaign Laboratory for analysis starting in July. Pesticide samples were refrigerated and sent to the Springfield Laboratory for analysis.

Shore Water Sampling

The twenty-six beaches listed below were the shore water sampling stations during 1976 (Figures 1 and 2). Samples were collected twice per month, with a total number of 14 samplings at each station. Samples were collected just below the surface in approximately 2½ feet of water. The shore water sampling season extended from April 7 to October 19, 1976.

Table 1. Beach locations sampled in 1976.

Winthrop Harbor - Main Street
Illinois Beach State Park
Zion - Route 173
Waukegan - North
Waukegan - Central
North Chicago - Foss Park
Lake Bluff - Center Avenue
Lake Forest - Westminster Avenue
Highwood - Walker Avenue
Highland Park - Park Avenue
Highland Park - Ravine Drive
Highland Park - Cary Avenue
Glencoe - Park Avenue
Winnetka - Lloyd Park
Kenilworth - Kenilworth Avenue
Wilmette - Lake Avenue
Evanston - Dempster Street
Chicago - Touhy Avenue
Chicago - Bryn Mawr Avenue
Chicago - Montrose Avenue
Chicago - North Avenue
Chicago - 12th Street
Chicago - 31st Street
Chicago - 63rd Street
Chicago - 76th Street
Chicago - 100th Street

Offshore Water Sampling

Lake samples for monitoring offshore or "open" water quality were obtained at the intakes of five municipal water filtration plants utilizing Lake Michigan as their source of water supply.

Raw water samples were collected twice monthly at the Zion-Benton, Highland Park, Evanston, Chicago Central and Chicago South water plants. The number of intakes and distance from shore is presented in Table 2.

FIG. 1 Location of North Shore beaches and facilities influencing their quality.

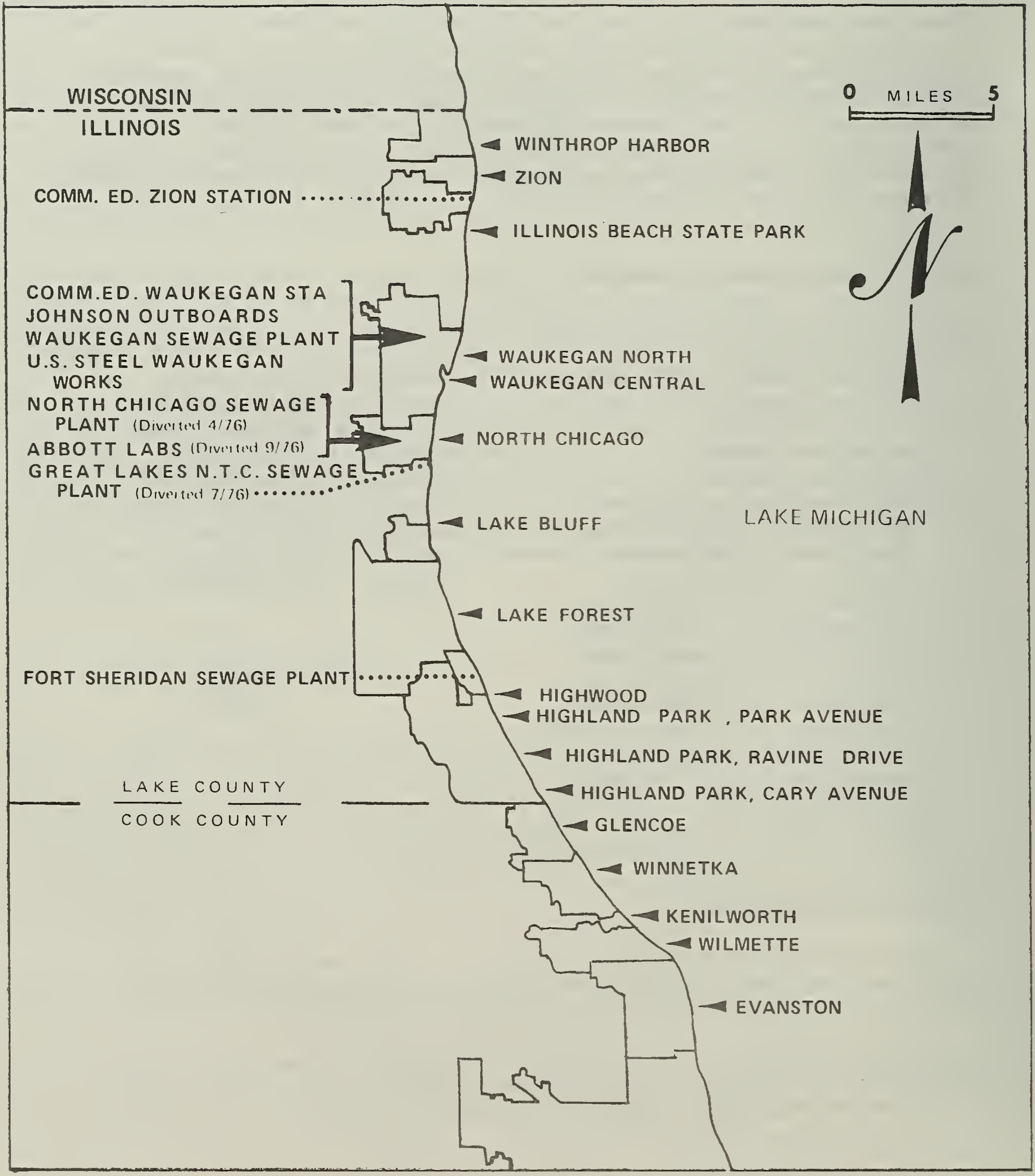

FIG. 2 Location of Chicago beaches and facilities influencing their quality.

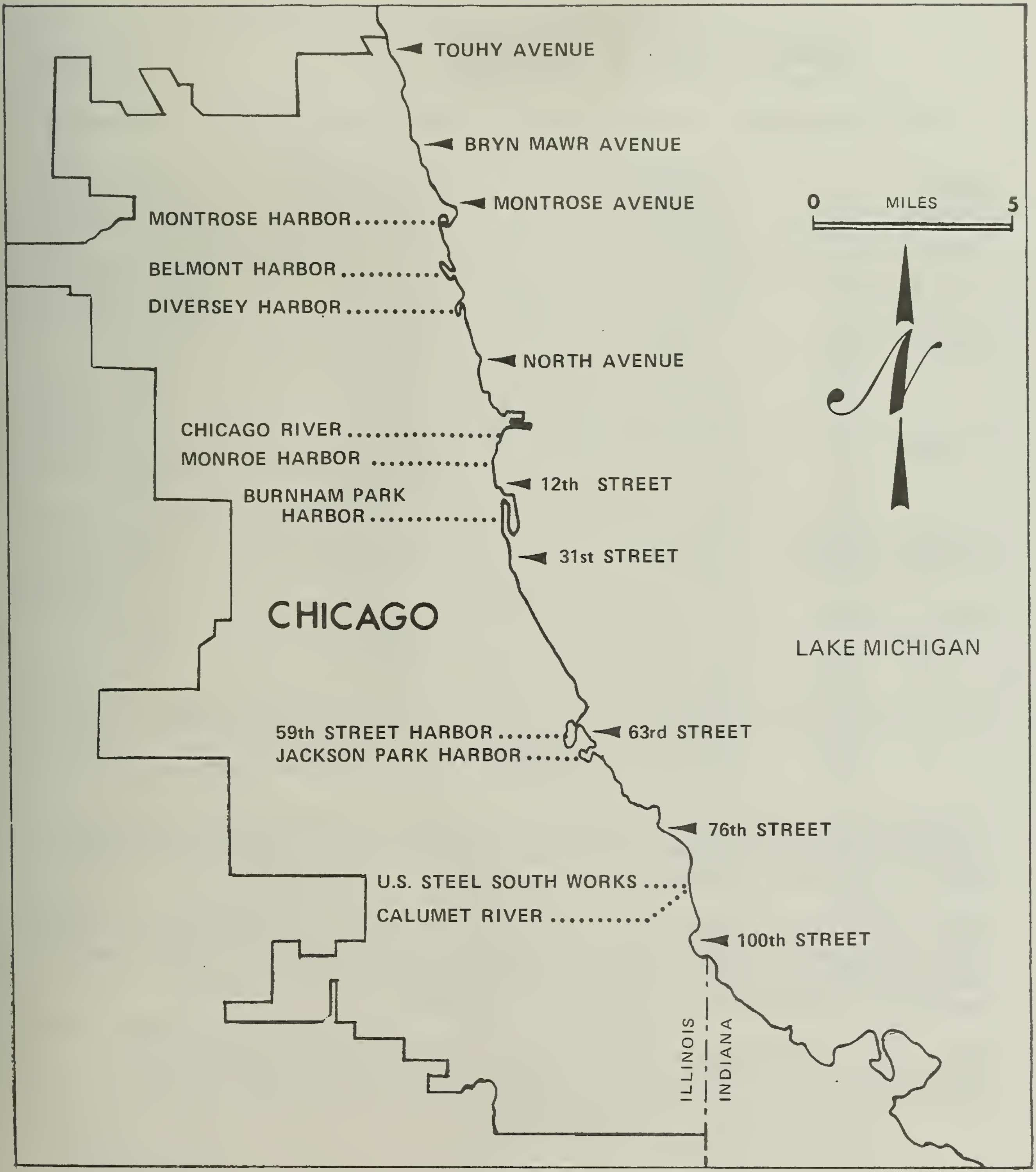

Table 2. Location of raw water intakes monitored at municipal water filtration plants in 1976.

Name of Plant	Number of Intakes	Distance of Intake from Shore (ft.)	Depth drawn from (ft.)
Zion-Benton	1	2,700	37
Highland Park	3	1,000	9
		2,000	20
		3,500	28
Evanston	3	1,800	16
		2,600	18
		5,600	28
Chicago Central	2	Shore	20
		13,000	35
Chicago South	2	Shore	24
		12,100	32

TURBIDITY

Turbidity is a measure of the extent to which light penetration in water is diminished by the presence of suspended and colloidal matter. Measurement of turbidity is expressed in turbidity units (TU).

Beach turbidities ranged from 1 to 200 TU. Averages by station ranged from 4 TU at Chicago's 100th Street beach to 44 TU at Highwood. The average of 362 samples was 20 TU (Table 3). The highest levels were recorded at the beaches in Highland Park and adjacent Highwood.

Water plant turbidities ranged from 1 to 52 TU. Averages by station ranged from 3 to 10 TU, and the average of 119 samples was 6 TU.

Table 3. Turbidity levels recorded at Lake Michigan beaches and water plants in 1976. Values are expressed in turbidity units (TU).

Sampling Location	Samples Analyzed	Range	Average Concentration
Beaches			
Winthrop Harbor	14	2 - 80	22
Zion	14	1 - 80	19
Illinois Beach State Park	14	1 - 130	26
Waukegan North	14	1 - 80	14
Waukegan Central	14	1 - 95	15
North Chicago	14	1 - 72	25
Lake Bluff	14	1 - 60	24
Lake Forest	14	1 - 80	24
Highwood	14	2 - 110	44
Highland Park - Park Avenue	14	2 - 105	32
Highland Park - Ravine Drive	14	3 - 100	40
Highland Park - Cary Avenue	13	2 - 200	43
Glencoe	14	1 - 66	28
Winnetka	14	1 - 62	21
Kenilworth	14	1 - 60	16
Wilmette	14	2 - 44	18
Evanston	14	2 - 50	15
Chicago - Touhy Avenue	14	2 - 50	16
Chicago - Bryn Mawr Avenue	14	1 - 69	19
Chicago - Montrose Avenue	14	1 - 48	16
Chicago - North Avenue	13	1 - 34	10
Chicago - 12th Street	14	1 - 14	5
Chicago - 31st Street	14	2 - 44	13
Chicago - 63rd Street	14	1 - 37	10
Chicago - 76th Street	14	1 - 25	9
Chicago - 100th Street	14	1 - 10	4
	362	1 - 200	20
Water Plants			
Zion - Benton	24	1 - 28	9
Highland Park	24	2 - 52	10
Evanston	23	1 - 28	6
Chicago Central	24	1 - 6	3
Chicago South	24	1 - 10	3
	119	1 - 52	6

Table 4. Maximum monthly temperatures recorded at Lake Michigan beaches in 1976. Values are in degrees Fahrenheit.

Standard: Maximum	55°	60°	70°	80°	80°	80°	65°
Sampling Location	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.
Winthrop Harbor	51	55	60	60	73	61	56
Zion	51	60	62	69	74	63	57
Illinois Beach State Park	52	58	61	70	75	63	54
Waukegan North	55	62	65	69	79	64	58
Waukegan Central	55	63	60	72	75	70	60
North Chicago	52	57	60	65	72	64	59
Lake Bluff	54	57	65	65	74	65	58
Lake Forest	54	58	65	67	74	65	58
Highwood	55	58	65	73	73	64	55
Highland Park - Park Avenue	55	57	65	77	73	63	55
Highland Park - Ravine Drive	56	58	66	76	74	62	55
Highland Park - Cary Avenue	54	58	69	74	73	63	55
Glencoe	57	58	65	73	74	66	56
Winnetka	58	59	65	73	76	75	56
Kenilworth	58	57	65	75	74	70	56
Wilmette	59	59	65	73	75	70	56
Evanston	57	57	65	70	74	68	55
Chicago - Touhy Avenue	58	56	65	69	74	71	51
Chicago - Bryn Mawr Avenue	58	65	71	74	75	71	55
Chicago - Montrose Avenue	58	60	69	74	73	72	55
Chicago - North Avenue	59	59	61	75	75	74	56
Chicago - 12th Street	57	56	65	75	73	72	58
Chicago - 31st Street	57	62	68	70	74	73	59
Chicago - 63rd Street	59	63	64	73	74	74	56
Chicago - 76th Street	60	59	65	75	72	72	56
Chicago - 100th Street	60	59	63	75	74	72	57

TEMPERATURE

Temperature is a controlling factor in the aquatic environment. It affects the oxygen carrying capacity of a body of water, rates of biochemical reactions, and the spawning, hatching, growth, and migration of aquatic organisms.

Because heated discharges may disrupt aquatic ecosystems, all sources of heated effluents, outside of a defined mixing zone, may not raise the ambient temperatures above the monthly maximums listed in Table 5.

In April, water temperatures at 15 of the 26 beaches were above the monthly limit. These temperatures ranged from 56° to 60°F. The monthly limit in May was exceeded at five beaches when temperatures ranged from 62°to 65°F (Table 4).

Monthly limits at the water plants were exceeded on six occasions in March, April, May, and October (Table 5).

Table 5. Maximum monthly temperatures recorded at five Lake Michigan municipal water filtration plants in 1976. Values are in degrees Fahrenheit.

Standard: Maximum	45°	45°	45°	55°	60°	70°	80°	80°	80°	65°	60°	50°
Sampling Location	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Water Plants												
Zion-Benton	38	45	45	49	53	55	60	71	65	69	50	43
Highland Park	39	44	46	57	56	60	65	71	64	60	49	48
Evanston	39	43	45	56	65	59	68	73	66	60	47	41
Chicago Central	39	45	48	54	55	60	69	75	71	63	53	43
Chicago South	35	44	45	54	55	60	70	74	70	60	48	40

pH

pH is the logarithm of the reciprocal of the hydrogen ion concentration. In practice, it is the measurement of the concentration of hydrogen ions. By definition, the pH range is from 0 (very acidic) to 14 (very alkaline). Since the concentration of hydrogen ions regulates the degree of dissociation of many substances, pH may be a significant factor in determining limiting threshold concentrations in natural waters. Abnormal fluctuations in pH may be an indication of industrial waste discharges. The Lake Michigan Standard requires pH values to be within the range of 7.0 to 9.0 except for natural causes.

During the year, 362 pH analyses were performed on beach samples. All values were within the range of 8.0 to 8.7, and the median of all samples was 8.4 (Table 6).

pH values at the water plants ranged from 8.1 to 8.7. The median of 119 samples was 8.4.

AMMONIA NITROGEN (as N)

Ammonia nitrogen is one of the compounds resulting from the metabolic activity of living organisms. It may be present in surface waters as a result of agricultural runoff, certain industrial wastes, and runoff from pastures or feedlots. It is a component of sewage and relatively high concentrations may be found in the effluents of sewage treatment facilities. The Lake Michigan Standard is 0.02 mg/l.

Excessive concentrations of ammonia nitrogen were found at all 26 beaches in 1976. Maximum values ranged from 0.09 mg/l at the Wilmette beach to 2.10 mg/l at Chicago's 12th Street beach. The highest average concentrations were found at the two Waukegan beaches, where concentrations averaged 0.33 and 0.24 mg/l at the North and Central beaches, respectively. Concentrations higher than 0.02 mg/l were found in 87.4% of the Lake County and 79.5% of the Cook County samples. Overall, 83.1% of the samples analyzed had excessive levels of ammonia nitrogen. The annual average of 0.11 mg/l for the Lake County beaches was significantly higher than the 0.07 mg/l annual average found at the Cook County beaches. The average of all samples was 0.09 mg/l (Table 1).

Excessive levels of ammonia nitrogen were found at all five water plants. In 119 samples analyzed, 77.3% exceeded the 0.02 mg/l standard. Maximum concentrations ranged from 0.13 to 0.23 mg/l, and the average of all samples was 0.06 mg/l.

Table 6. pH values at Lake Michigan beaches and water plants in 1976. Values are expressed in pH units.

Standard: 7.0 - 9.0

Sampling Location	Samples Analyzed	Range	Median
Beaches			
Winthrop Harbor	14	8.1 - 8.5	8.4
Zion	14	8.3 - 8.5	8.4
Illinois Beach State Park	14	8.3 - 8.5	8.4
Waukegan North	14	8.2 - 8.5	8.4
Waukegan Central	14	8.1 - 8.5	8.3
North Chicago	14	8.2 - 8.5	8.4
Lake Bluff	14	8.2 - 8.5	8.4
Lake Forest	14	8.2 - 8.5	8.4
Highwood	14	8.2 - 8.5	8.4
Highland Park - Park Avenue	14	8.2 - 8.6	8.4
Highland Park - Ravine Drive	14	8.3 - 8.5	8.5
Highland Park - Cary Avenue	13	8.0 - 8.6	8.4
Glencoe	14	8.2 - 8.6	8.4
Winnetka	14	8.2 - 8.7	8.4
Kenilworth	14	8.3 - 8.6	8.4
Wilmette	14	8.2 - 8.6	8.4
Evanston	14	8.2 - 8.5	8.4
Chicago - Touhy Avenue	14	8.2 - 8.6	8.3
Chicago - Bryn Mawr Avenue	14	8.3 - 8.5	8.4
Chicago - Montrose Avenue	14	8.2 - 8.6	8.4
Chicago - North Avenue	13	8.2 - 8.5	8.3
Chicago - 12th Street	14	8.2 - 8.6	8.4
Chicago - 31st Street	14	8.2 - 8.5	8.4
Chicago - 63rd Street	14	8.2 - 8.6	8.3
Chicago - 76th Street	14	8.2 - 8.5	8.4
Chicago - 100th Street	14	8.0 - 8.5	8.4
	362	8.0 - 8.7	8.4
Water Plants			
Zion - Benton	24	8.1 - 8.6	8.4
Highland Park	24	8.1 - 8.6	8.4
Evanston	23	8.1 - 8.7	8.4
Chicago Central	24	8.2 - 8.6	8.4
Chicago South	24	8.1 - 8.7	8.4
	119	8.1 - 8.7	8.4

Table 7. Ammonia nitrogen (as N) concentrations at Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Standard: 0.02 mg/l

Sampling Location	Range	Average	Number of Samples Exceeding Standard
Beaches			
Winthrop Harbor	0.00 - 0.15	0.07	12 of 14
Zion	0.02 - 0.15	0.08	12 of 14
Illinois Beach State Park	0.02 - 0.12	0.07	13 of 14
Waukegan North	0.04 - 1.60	0.33	14 of 14
Waukegan Central	0.00 - 1.10	0.24	13 of 14
North Chicago	0.01 - 0.55	0.10	13 of 14
Lake Bluff	0.02 - 0.16	0.07	13 of 14
Lake Forest	0.02 - 0.21	0.06	13 of 14
Highwood	0.00 - 0.23	0.06	9 of 14
Highland Park - Park Avenue	0.00 - 0.18	0.08	10 of 14
Highland Park - Ravine Drive	0.02 - 0.11	0.05	13 of 14
Highland Park - Cary Avenue	0.00 - 0.17	0.06	11 of 13
Glencoe	0.00 - 0.22	0.05	10 of 14
Winnetka	0.00 - 0.19	0.05	11 of 14
Kenilworth	0.00 - 0.10	0.03	9 of 14
Wilmette	0.00 - 0.09	0.04	9 of 14
Evanston	0.00 - 0.15	0.06	10 of 14
Chicago - Touhy Avenue	0.00 - 0.17	0.06	11 of 14
Chicago - Bryn Mawr Avenue	0.00 - 0.14	0.06	13 of 14
Chicago - Montrose Avenue	0.00 - 0.12	0.06	12 of 14
Chicago - North Avenue	0.00 - 0.22	0.07	10 of 13
Chicago - 12th Street	0.00 - 2.10	0.20	11 of 14
Chicago - 31st Street	0.00 - 0.29	0.08	12 of 14
Chicago - 63rd Street	0.00 - 0.15	0.06	11 of 14
Chicago - 76th Street	0.00 - 0.15	0.07	13 of 14
Chicago - 100th Street	0.00 - 0.19	0.08	13 of 14
	0.00 - 2.10	0.09	301 of 362
Water Plants			
Zion-Benton	0.00 - 0.13	0.06	17 of 24
Highland Park	0.00 - 0.16	0.05	17 of 24
Evanston	0.00 - 0.18	0.07	18 of 23
Chicago Central	0.00 - 0.22	0.07	20 of 24
Chicago South	0.01 - 0.23	0.07	20 of 24
	0.00 - 0.23	0.06	92 of 119

Table 8. Total plankton counts recorded at Lake Michigan beaches and water plants in 1976. Counts are expressed as the number per milliliter.

Sampling Location	Samples Analyzed	Minimum	Maximum	Average
Beaches				
Winthrop Harbor	12	435	1989	1066
Zion	12	435	2379	970
Illinois Beach State Park	12	435	1560	830
Waukegan North	12	390	1365	826
Waukegan Central	12	435	1287	810
North Chicago	12	351	1521	846
Lake Bluff	12	507	1092	826
Lake Forest	12	435	1950	858
Highwood	12	351	1716	881
Highland Park - Park Avenue	12	312	1989	826
Highland Park - Ravine Drive	12	429	2262	842
Highland Park - Cary Avenue	11	390	1755	936
Glencoe	12	429	1014	757
Winnetka	12	273	1716	890
Kenilworth	12	117	1287	803
Wilmette	12	390	1638	1040
Evanston	12	351	1209	826
Chicago - Touhy Avenue	12	468	3042	1209
Chicago - Bryn Mawr Avenue	12	468	2496	1391
Chicago - Montrose Avenue	12	429	2574	1420
Chicago - North Avenue	11	741	2340	1248
Chicago - 12th Street	12	468	1677	978
Chicago - 31st Street	12	702	1638	1126
Chicago - 63rd Street	12	624	1638	1327
Chicago - 76th Street	12	468	1833	1216
Chicago - 100th Street	12	507	2184	1216
	310	117	3042	998
Water Plants				
Zion - Benton	14	234	1209	755
Highland Park	14	195	1482	850
Evanston	14	156	1248	861
Chicago Central	14	273	1482	831
Chicago South	13	78	1716	825
	69	78	1716	824

Table 9. Chloride concentrations at Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Standard: 12 mg/l

Sampling Location	Range	Average	Number of Samples Exceeding Standard
Beaches			
Winthrop Harbor	8 - 14	9	1 of 14
Zion	8 - 13	9	1 of 14
Illinois Beach State Park	8 - 12	9	0 of 14
Waukegan North	8 - 25	11	1 of 14
Waukegan Central	8 - 13	10	0 of 14
North Chicago	8 - 15	10	2 of 14
Lake Bluff	8 - 11	9	0 of 14
Lake Forest	8 - 12	9	0 of 14
Highwood	8 - 12	9	0 of 14
Highland Park - Park Avenue	8 - 13	10	1 of 14
Highland Park - Ravine Drive	8 - 13	9	1 of 14
Highland Park - Cary Avenue	8 - 34	11	1 of 13
Glencoe	8 - 12	9	0 of 14
Winnetka	8 - 12	9	0 of 14
Kenilworth	8 - 11	9	0 of 14
Wilmette	8 - 11	9	0 of 14
Evanston	8 - 11	9	0 of 14
Chicago - Touhy Avenue	8 - 11	9	0 of 14
Chicago - Bryn Mawr Avenue	8 - 13	9	1 of 14
Chicago - Montrose Avenue	8 - 11	9	0 of 14
Chicago - North Avenue	8 - 10	9	0 of 13
Chicago - 12th Street	8 - 10	9	0 of 14
Chicago - 31st Street	8 - 10	9	0 of 14
Chicago - 63rd Street	8 - 10	9	0 of 14
Chicago - 76th Street	8 - 10	9	0 of 14
Chicago - 100th Street	9 - 10	9	0 of 14
	8 - 34	9	9 of 362
Water Plants			
Zion - Benton	8 - 13	9	1 of 24
Highland Park	8 - 11	9	0 of 24
Evanston	8 - 11	9	0 of 23
Chicago Central	8 - 10	9	0 of 24
Chicago South	8 - 11	9	0 of 24
	8 - 13	9	1 of 119

PLANKTON

Plankton are the minute, mostly microscopic plants and animals that drift in the water subject to the action of waves and currents. Certain varieties clog filters resulting in increased costs of water treatment. Others are responsible for taste and odor problems in drinking water. In aquatic food chains they are a primary source of food for higher organisms. In water quality monitoring they serve to indicate eutrophication trends.

Maximum plankton counts at the beaches ranged from 1014 to 3042/ml. The average by station ranged from 757 to 1420/ml, and the average of 310 samples was 998/ml (Table 8).

Maximum plankton counts at the water plants ranged from 1209 to 1716/ml. The average by station ranged from 755 to 861/ml, and the average of 69 samples was 824/ml.

CHLORIDE

Chlorides are one of the most common naturally occurring chemical constituents of surface waters. Sanitary wastes and certain industrial discharges may contribute significant amounts to receiving streams. Ferric chloride is being used at several of the sewage treatment plants tributary to Lake Michigan to reduce effluent phosphorus levels. The Lake Michigan Standard is 12 mg/l.

Maximum chloride concentrations at the beaches ranged from 10 mg/l at the six southernmost Chicago beaches to 34 mg/l at the Cary Avenue beach in Highland Park. Concentrations above 12 mg/l occurred in 4.8% of the Lake County and 0.5% of the Cook County samples. Annual average concentrations for Lake and Cook Counties were 10 and 9 mg/l, respectively, and the average of all samples was 9 mg/l (Table 9).

Chloride concentrations at the water plants ranged from 8 to 13 mg/l. One of 119 samples exceeded the 12 mg/l standard.

CYANIDE

Cyanide is a toxic compound present in the waste discharges from gas works, coke ovens, metal cleaning and electroplating processes, scrub waters from steel mills, and from chemical industries.

During the year, 180 beach samples were analyzed for cyanide. In May, a measurable concentration of 0.01 mg/l was recorded from the Waukegan North beach.

Measurable concentrations of cyanide were not found in 59 water plant samples.

Table 10. Fluoride concentration at the Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Standard: 1.4 mg/l

Sampling Location	Samples Analyzed	Range	Average
Beaches			
Winthrop Harbor	14	0.2 - 0.3	0.2
Zion	14	0.2 - 0.3	0.2
Illinois Beach State Park	14	0.2 - 0.3	0.2
Waukegan North	14	0.2 - 0.4	0.2
Waukegan Central	14	0.2 - 0.4	0.2
North Chicago	14	0.2 - 0.3	0.2
Lake Bluff	14	0.2 - 0.3	0.2
Lake Forest	14	0.2 - 0.3	0.2
Highwood	14	0.2 - 0.3	0.2
Highland Park - Park Avenue	14	0.2 - 0.3	0.2
Highland Park - Ravine Drive	14	0.2 - 0.2	0.2
Highland Park - Cary Avenue	13	0.2 - 0.4	0.2
Glencoe	14	0.2 - 0.3	0.2
Winnetka	14	0.2 - 0.2	0.2
Kenilworth	14	0.2 - 0.2	0.2
Wilmette	14	0.2 - 0.2	0.2
Evanston	14	0.2 - 0.2	0.2
Chicago - Touhy Avenue	14	0.2 - 0.2	0.2
Chicago - Bryn Mawr Avenue	14	0.2 - 0.2	0.2
Chicago - Montrose Avenue	14	0.2 - 0.2	0.2
Chicago - North Avenue	13	0.2 - 0.2	0.2
Chicago - 12th Street	14	0.2 - 0.3	0.2
Chicago - 31st Street	14	0.2 - 0.2	0.2
Chicago - 63rd Street	14	0.2 - 0.2	0.2
Chicago - 76th Street	14	0.2 - 0.2	0.2
Chicago - 100th Street	14	0.2 - 0.3	0.2
	362	0.2 - 0.4	0.2
Water Plants			
Zion - Benton	24	0.1 - 0.3	0.2
Highland Park	24	0.2 - 0.2	0.2
Evanston	23	0.2 - 0.4	0.2
Chicago Central	24	0.2 - 0.2	0.2
Chicago South	24	0.2 - 0.2	0.2
	119	0.1 - 0.4	0.2

FLUORIDES

Fluorides are used in the manufacturing of steel, glass, enamel, and in insecticide preparations. They also have disinfecting and preserving applications. At lower concentrations, fluorides in drinking water reduce the incidence of dental caries. However, at higher concentrations, toxic properties are exhibited.

Fluoride concentrations at the beaches ranged from 0.2 to 0.4 mg/l, and the average of all samples was 0.2 mg/l. There appears to be little variability in beach fluoride concentrations since 85.6% of the Lake County and 97.9% of the Cook County samples had a value of 0.2 mg/l (Table 10).

The maximum fluoride concentrations at the water plants ranged from 0.2 to 0.4 mg/l and the average of all samples was 0.2 mg/l. In 119 samples analyzed, 96.6% had a value of 0.2 mg/l.

PHENOLS

Phenols are associated with industrial wastes from coal distillation processes and the manufacture of plastics, dyes, and disinfectants. Relatively small concentrations can cause taste and odor problems in public water supplies.

Measurable concentrations of phenols were found in 12 of 362 beach samples. Values ranged from 0.005 to 0.009 mg/l. The highest concentration, 0.009 mg/l, was recorded once each from Kenilworth and the Cary Avenue beach in Highland Park. A value of 0.008 mg/l was recorded from the Waukegan Central Beach while one sample from Evanston had a value of 0.007 mg/l. Wilmette and Chicago's Touhy Avenue beach each recorded a value of 0.006 mg/l. A value of 0.005 mg/l was recorded once each from the Illinois Beach State Park, Waukegan's North Beach, Lake Bluff, and Evanston while this value was found twice in samples from Winnetka.

Measurable concentrations of phenols were found in only one of 119 water plant samples. A concentration of 0.005 mg/l was recorded from the Evanston water plant.

Table 11. Sulfate concentrations at Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Standard: 24 mg/l

Sample Location	Range	Average	Number of Samples Exceeding Standard
Beaches			
Winthrop Harbor	19 - 28	21	1 of 14
Zion	18 - 26	21	1 of 14
Illinois Beach State Park	18 - 25	21	1 of 14
Waukegan North	18 - 55	25	2 of 14
Waukegan Central	19 - 25	22	2 of 14
North Chicago	18 - 38	22	1 of 14
Lake Bluff	19 - 24	21	0 of 14
Lake Forest	18 - 25	21	1 of 14
Highwood	18 - 25	21	1 of 14
Highland Park-Park Avenue	18 - 25	21	1 of 14
Highland Park-Ravine Drive	19 - 25	21	1 of 14
Highland Park-Cary Avenue	20 - 26	21	2 of 13
Glencoe	19 - 23	21	0 of 14
Winnetka	17 - 24	20	0 of 14
Kenilworth	17 - 23	20	0 of 14
Wilmette	17 - 23	20	0 of 14
Evanston	17 - 23	20	0 of 14
Chicago-Touhy Avenue	17 - 24	20	0 of 14
Chicago-Bryn Mawr Avenue	18 - 24	20	0 of 14
Chicago-Montrose Avenue	17 - 23	20	0 of 14
Chicago-North Avenue	17 - 24	21	0 of 13
Chicago-12th Street	19 - 24	21	0 of 14
Chicago-31st Street	18 - 24	21	0 of 14
Chicago-63rd Street	18 - 24	20	0 of 14
Chicago-76th Street	18 - 24	21	0 of 14
Chicago-100th Street	18 - 25	21	1 of 14
	17 - 55	21	15 of 362
Water Plants			
Zion-Benton	18 - 27	21	2 of 24
Highland Park	18 - 26	21	3 of 24
Evanston	17 - 28	21	2 of 23
Chicago Central	18 - 28	21	1 of 24
Chicago South	18 - 28	21	1 of 24
	17 - 28	21	9 of 119

SULFATE

Sulfate is a component of natural bodies of water. Abnormal fluctuations in background levels may be the result of industrial waste discharges. In drinking water supplies, high sulfate concentrations may have a cathartic effect. The Lake Michigan Standard is 24 mg/l.

Maximum sulfate concentrations at the beaches ranged from 17 to 55 mg/l, and the average of all samples was 21 mg/l. Average concentrations for Lake and Cook Counties were 22 and 21 mg/l, respectively. Excessive sulfate concentrations were found in 8.4% of the Lake County and 0.5% of the Cook County samples (Table 11).

Maximum sulfate concentrations at the water plants ranged from 26 to 28 mg/l, and the average of all samples was 21 mg/l. Concentrations exceeding 24 mg/l were found in nine samples involving all five water plants.

TOTAL PHOSPHORUS (as P)

Phosphorus is found in domestic sewage, some industrial wastes, and in drainage from agricultural areas. It is one of the nutrients responsible for excessive algae growth. An effluent standard for waste discharges to Lake Michigan has resulted in the interim use of chemicals to reduce phosphorus levels in sewage treatment plant effluents. The Lake Michigan Standard is 0.007 mg/l.

Excessive phosphorus concentrations were found at all 26 beaches in 1976. Maximum concentrations ranged from 0.072 to 0.700 mg/l, and the average of all samples was 0.074 mg/l. County averages were 0.080 and 0.069 mg/l for Lake and Cook Counties, respectively. Concentrations exceeding 0.007 mg/l were found in 100% of the Lake County and 98.4% of the Cook County samples (Table 12).

Maximum phosphorus concentrations at the water plants ranged from 0.062 to 1.800 mg/l, and the average of all samples was 0.051 mg/l. Eighty-seven of the 100 samples had concentrations exceeding the 0.007 mg/l standard.

Table 12. Total phosphorus concentrations at Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Standard: 0.007 mg/l

Sampling Location	Range	Average	Number of Samples Exceeding Standard
Beaches			
Winthrop Harbor	0.026 - 0.140	0.079	14 of 14
Zion	0.019 - 0.205	0.073	14 of 14
Illinois Beach State Park	0.011 - 0.210	0.078	14 of 14
Waukegan North	0.011 - 0.142	0.075	13 of 13
Waukegan Central	0.008 - 0.170	0.071	14 of 14
North Chicago	0.024 - 0.260	0.084	14 of 14
Lake Bluff	0.034 - 0.280	0.093	14 of 14
Lake Forest	0.023 - 0.240	0.070	14 of 14
Highwood	0.024 - 0.160	0.074	14 of 14
Highland Park-Park Avenue	0.024 - 0.095	0.062	14 of 14
Highland Park-Ravine Drive	0.030 - 0.420	0.099	14 of 14
Highland Park-Cary Avenue	0.029 - 0.560	0.098	13 of 13
Glencoe	0.014 - 0.090	0.046	14 of 14
Winnetka	0.003 - 0.100	0.048	12 of 13
Kenilworth	0.015 - 0.125	0.058	14 of 14
Wilmette	0.025 - 0.250	0.079	14 of 14
Evanston	0.028 - 0.350	0.082	12 of 12
Chicago-Touhy Avenue	0.035 - 0.105	0.063	13 of 13
Chicago-Bryn Mawr Avenue	0.030 - 0.170	0.070	14 of 14
Chicago-Montrose Avenue	0.008 - 0.190	0.074	14 of 14
Chicago-North Avenue	0.034 - 0.222	0.089	13 of 13
Chicago-12th Street	0.000 - 0.072	0.045	12 of 13
Chicago-31st Street	0.000 - 0.160	0.055	13 of 14
Chicago-63rd Street	0.011 - 0.130	0.058	13 of 13
Chicago-76th Street	0.009 - 0.700	0.094	14 of 14
Chicago-100th Street	0.009 - 0.490	0.087	13 of 13
	0.000 - 0.700	0.074	351 of 354
Water Plants			
Zion-Benton	0.000 - 0.132	0.035	19 of 22
Highland Park	0.000 - 0.076	0.030	19 of 21
Evanston	0.000 - 1.800	0.116	17 of 20
Chicago Central	0.000 - 0.062	0.022	16 of 19
Chicago South	0.000 - 0.550	0.053	16 of 18
	0.000 - 1.800	0.051	87 of 100

Table 13. Total dissolved solids (TDS) concentrations at Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Standard: 180 mg/l

Sampling Location	Range	Average	Number of Samples Exceeding Standard
Beaches			
Winthrop Harbor	162 - 195	170	3 of 14
Zion	162 - 189	171	3 of 14
Illinois Beach State Park	162 - 189	170	2 of 14
Waukegan North	161 - 259	178	4 of 14
Waukegan Central	165 - 185	173	2 of 14
North Chicago	163 - 198	172	3 of 14
Lake Bluff	162 - 180	169	0 of 14
Lake Forest	161 - 180	168	0 of 14
Highwood	161 - 184	169	1 of 14
Highland Park-Park Avenue	161 - 185	169	1 of 14
Highland Park-Ravine Drive	161 - 190	169	1 of 14
Highland Park-Cary Avenue	161 - 251	174	1 of 13
Glencoe	161 - 180	168	0 of 14
Winnetka	160 - 183	168	1 of 14
Kenilworth	161 - 180	167	0 of 14
Wilmette	161 - 178	167	0 of 14
Evanston	161 - 178	168	0 of 14
Chicago-Touhy Avenue	161 - 175	167	0 of 14
Chicago-Bryn Mawr Avenue	160 - 182	168	1 of 14
Chicago-Montrose Avenue	161 - 178	168	0 of 14
Chicago-North Avenue	161 - 175	167	0 of 13
Chicago-12th Street	162 - 176	168	0 of 14
Chicago-31st Street	163 - 174	169	0 of 14
Chicago-63rd Street	163 - 174	168	0 of 14
Chicago-76th Street	164 - 174	168	0 of 14
Chicago-100th Street	166 - 182	171	1 of 14
	160 - 259	169	24 of 362
Water Plants			
Zion-Benton	159 - 184	170	3 of 24
Highland Park	160 - 180	169	0 of 24
Evanston	160 - 184	168	1 of 23
Chicago Central	159 - 174	166	0 of 24
Chicago South	159 - 178	169	0 of 24
	159 - 184	168	4 of 119

TOTAL DISSOLVED SOLIDS

Dissolved solids in high concentrations are undesirable in drinking water supplies because of their possible laxative and unpalatable taste properties. In the aquatic ecosystem they provide essential nutrients in productivity cycles. At very high concentrations they may exert osmotic or toxic stresses on fish and other aquatic life. The Lake Michigan Standard is 180 mg/l.

Maximum concentrations of total dissolved solids at the beaches ranged from 174 to 259 mg/l. Averages by county ranged from 171 mg/l for the Lake County stations to 168 mg/l for the Cook County beaches. The average of all samples was 169 mg/l. During the year, 12.6% of the Lake County and 1.5% of the Cook County samples contained concentrations higher than 180 mg/l (Table 13).

Maximum concentrations of total dissolved solids at the water plants ranged from 174 to 184 mg/l, and the average of 119 samples was 168 mg/l. Excessive total dissolved solids were found in 3.4% of the samples.

RADIOACTIVITY

In addition to naturally occurring background radiation, radioactive substances may enter the aquatic environment as discharges from nuclear facilities, from users of radionuclides, through the activities associated with uranium ore mining, and as atmospheric fall-out. There is no standard for gross alpha emissions. Gross beta values may not exceed 100 pCi/l.

Maximum gross alpha values at the beaches ranged from 0.8 to 5.2 pCi/l. The median by station ranged from 0.4 to 1.6 pCi/l, and the median of 180 samples was 0.8 pCi/l. Gross beta values were well below 100 pCi/l with maximum values ranging from 3.7 to 10.3 pCi/l. The median by station ranged from 2.8 to 6.6 pCi/l, and the median of all samples was 3.6 pCi/l (Table 14).

Maximum gross alpha values at the water plants ranged from 1.0 to 1.4 pCi/l, and the median of 60 samples was 0.5 pCi/l. Maximum gross beta values ranged from 4.5 to 5.8 pCi/l, and the median of all samples was 3.2 pCi/l.

Table 14. Gross alpha and beta emissions recorded at Lake Michigan beaches and water plants in 1976. Values are expressed in pCi/l.

Sampling Location	Samples Analyzed	Gross Alpha		Gross Beta	
		Range	Median	Range	Median
Beaches					
Winthrop Harbor	7	0.0 - 1.4	0.5	1.7 - 6.7	3.4
Zion	7	0.0 - 1.3	0.8	3.2 - 7.4	3.8
Illinois Beach State Park	7	0.2 - 5.2	1.0	2.8 - 10.3	3.7
Waukegan North	7	0.0 - 1.8	0.8	1.8 - 7.2	3.4
Waukegan Central	7	0.1 - 3.9	0.5	1.0 - 8.3	3.4
North Chicago	7	0.2 - 2.3	0.5	1.9 - 6.9	3.5
Lake Bluff	7	0.2 - 2.6	0.8	1.2 - 6.4	3.4
Lake Forest	7	0.0 - 4.5	0.6	1.5 - 7.0	3.5
Highwood	7	0.1 - 3.2	1.3	3.0 - 8.1	5.0
Highland Park-Park Avenue	7	0.0 - 3.1	0.9	3.0 - 7.0	4.1
Highland Park-Ravine Drive	7	0.0 - 2.2	1.0	2.4 - 6.2	3.6
Highland Park-Cary Avenue	6	0.6 - 2.4	1.2	3.8 - 6.9	4.4
Glencoe	7	0.5 - 3.3	1.1	1.0 - 8.0	6.6
Winnetka	7	0.4 - 2.3	1.1	2.6 - 7.1	5.4
Kenilworth	7	0.4 - 1.4	1.0	3.1 - 8.0	4.3
Wilmette	7	0.4 - 2.3	0.9	0.6 - 6.9	3.5
Evanston	7	0.0 - 1.0	0.5	2.8 - 7.1	4.0
Chicago-Touhy Avenue	7	0.0 - 2.0	1.6	1.5 - 6.8	3.2
Chicago-Bryn Mawr Avenue	7	0.0 - 1.5	0.8	1.9 - 5.8	4.1
Chicago-Montrose Avenue	7	0.0 - 1.4	0.6	1.2 - 5.1	3.2
Chicago-North Avenue	6	0.4 - 1.1	0.7	1.9 - 4.7	3.2
Chicago-12th Street	7	0.2 - 1.3	0.5	2.2 - 4.2	3.5
Chicago-31st Street	7	0.2 - 1.3	1.0	2.2 - 5.4	3.0
Chicago-63rd Street	7	0.0 - 0.9	0.4	1.2 - 4.3	2.8
Chicago-76th Street	7	0.2 - 0.8	0.6	1.3 - 5.2	3.6
Chicago-100th Street	7	0.0 - 1.4	0.5	1.0 - 3.7	3.1
	180	0.0 - 5.2	0.8	0.6 - 10.3	3.6
Water Plants					
Zion-Benton	12	0.2 - 1.4	0.6	1.0 - 5.4	3.6
Highland Park	12	0.0 - 1.4	0.8	2.1 - 5.8	3.6
Evanston	12	0.1 - 1.2	0.6	1.1 - 4.8	3.4
Chicago Central	12	0.0 - 1.0	0.4	0.9 - 4.7	3.1
Chicago South	12	0.0 - 1.0	0.5	0.8 - 4.5	3.2
	60	0.0 - 1.4	0.5	0.8 - 5.8	3.2

FECAL COLIFORM

Present laboratory methods for the detection of disease-producing bacteria are complex, time-consuming and are not readily amenable to routine water quality monitoring programs. The fecal coliform group of bacteria, which are nonpathogenic inhabitants of the intestinal tracts of warmblooded animals, is closely associated with fecal and sewage discharges. Consequently, this group serves as a reliable indicator of recent sewage contamination.

The Lake Michigan fecal coliform standard, which is based on a minimum of five samples taken within a 30-day period, requires that the geometric mean not exceed 20 per 100 ml. Although Agency monitoring is conducted on a twice-per-month basis because of limited resources, annual geometric means were calculated and compared to the 20/100 ml standard for this report.

Annual geometric means ranged from 3/100 ml at Chicago's 63rd and 76th Street beaches to 77/100 ml at the Park Avenue beach in Highland Park. Six Lake County beaches had annual geometric means higher than 20/100 ml. Geometric means at the Lake and Cook County beaches were 19 and 8/100 ml, respectively. The geometric mean of all samples was 12/100 ml (Table 15).

Annual geometric means at the water plants ranged from 2 to 7/100 ml, and the geometric mean of all samples was 3/100 ml.

Table 15. Fecal coliform counts at Lake Michigan beaches and water plants in 1976. Counts are expressed as the number per 100 ml.

Standard: Geometric Mean 20/100 ml

Sampling Location	Samples Analyzed	Range	Annual Geometric Mean
Beaches			
Winthrop Harbor	14	1 - 3300	24
Zion	14	2 - 2000	28
Illinois Beach State Park	14	1 - 1000	19
Waukegan North	14	1 - 210	13
Waukegan Central	14	1 - 140	6
North Chicago	14	1 - 190	11
Lake Bluff	14	1 - 200	10
Lake Forest	14	1 - 200	8
Highwood	14	1 - 3800	25
Highland Park-Park Avenue	14	1 - 1600	77
Highland Park-Ravine Drive	14	1 - 1200	37
Highland Park-Cary Avenue	13	1 - 39,000	33
Glencoe	11	1 - 100	17
Winnetka	14	1 - 2100	14
Kenilworth	13	1 - 500	8
Wilmette	13	1 - 100	11
Evanston	14	1 - 400	14
Chicago-Touhy Avenue	14	1 - 1000	10
Chicago-Bryn Mawr Avenue	14	1 - 500	9
Chicago-Montrose Avenue	14	1 - 330	13
Chicago-North Avenue	13	1 - 1000	9
Chicago-12th Street	14	1 - 200	7
Chicago-31st Street	14	1 - 70	5
Chicago-63rd Street	14	1 - 100	3
Chicago-76th Street	14	1 - 44	3
Chicago-100th Street	14	1 - 300	11
	357	1 - 39,000	12
Water Plants			
Zion-Benton	24	1 - 50	3
Highland Park	24	1 - 2000	7
Evanston	23	1 - 50	2
Chicago Central	24	1 - 150	3
Chicago South	24	1 - 100	4
	119	1 - 2000	3

NITRATES + NITRITES (as N)

Nitrates are the metabolic end products of organic nitrogen decomposition. They are commonly found in surface waters as a result of the decomposition of organic nitrogen in polluted streams and from sewage effluents, agricultural runoff, cesspool leaching, and industrial discharges. Nitrites in natural waters result from bacterial action upon ammonia and organic nitrogen. Because they are readily oxidized to nitrates, nitrites are not normally found in significant concentrations in surface waters. If present in sufficient concentrations in public water supplies, nitrate-nitrite may cause infant methemoglobinemia, a disease causing blood changes and cyanosis.

Maximum nitrate-nitrite concentrations ranged from 0.3 to 1.0 mg/l. The average of all samples was 0.2 mg/l. In 167 Lake County samples, 82.6% had concentrations of 0.3 mg/l or less. The comparable Cook County percentage for 195 samples was 95.4% (Table 16).

Maximum nitrate-nitrite concentrations ranged from 0.3 to 0.5 mg/l, and the average of all samples was 0.3 mg/l. In 119 water plant samples, 89.1% had concentrations of 0.3 mg/l or less.

ALKALINITY

Alkalinity refers to the ability of water to neutralize acids. In the aquatic environment alkalinity serves as a buffer to prevent any abrupt change in the pH of the water which might otherwise affect fish and other aquatic organisms. The best waters for the support of a diversified aquatic life are those with a pH between 7 and 8 and a total alkalinity of 100 to 120 mg/l or more (McKee and Wolf, 1971).

Alkalinity levels at the beaches ranged from 102 to 130 mg/l. Averages by station ranged from 106 to 109 mg/l, and the average of all samples was 107 mg/l (Table 17).

Alkalinity levels at the water plants ranged from 102 to 120 mg/l. Averages by station ranged from 107 to 108 mg/l, and the average of 119 samples was 108 mg/l.

Table 16. Nitrate and nitrite (as N) concentrations at Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Standards: Nitrate-nitrogen 10 mg/l
Nitrite-nitrogen 1 mg/l

Sampling Location	Samples Analyzed	Range	Average
Beaches			
Winthrop Harbor	14	0.2 - 0.6	0.3
Zion	14	0.2 - 0.8	0.3
Illinois Beach State Park	14	0.1 - 0.6	0.3
Waukegan North	14	0.2 - 0.4	0.3
Waukegan Central	14	0.2 - 0.5	0.3
North Chicago	14	0.1 - 0.4	0.3
Lake Bluff	14	0.2 - 0.5	0.3
Lake Forest	14	0.2 - 0.4	0.3
Highwood	14	0.1 - 0.4	0.2
Highland Park-Park Avenue	14	0.1 - 0.4	0.2
Highland Park-Ravine Drive	14	0.2 - 0.4	0.2
Highland Park-Cary Avenue	13	0.2 - 0.8	0.3
Glencoe	14	0.1 - 0.4	0.2
Winnetka	14	0.1 - 0.4	0.2
Kenilworth	14	0.1 - 0.4	0.2
Wilmette	14	0.1 - 0.4	0.2
Evanston	14	0.1 - 0.3	0.2
Chicago-Touhy Avenue	14	0.1 - 0.4	0.2
Chicago-Bryn Mawr Avenue	14	0.1 - 0.3	0.2
Chicago-Montrose Avenue	14	0.2 - 0.3	0.2
Chicago-North Avenue	13	0.2 - 0.3	0.2
Chicago-12th Street	14	0.2 - 0.4	0.2
Chicago-31st Street	14	0.1 - 0.3	0.2
Chicago-63rd Street	14	0.2 - 1.0	0.3
Chicago-76th Street	14	0.2 - 0.3	0.2
Chicago-100th Street	14	0.2 - 0.6	0.3
	362	0.1 - 1.0	0.2
Water Plants			
Zion-Benton	24	0.2 - 0.5	0.3
Highland Park	24	0.1 - 0.4	0.2
Evanston	23	0.2 - 0.5	0.3
Chicago Central	24	0.2 - 0.3	0.2
Chicago South	24	0.1 - 0.4	0.2
	119	0.1 - 0.5	0.3

Table 17. Alkalinity levels recorded at Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Sampling Location	Samples Analyzed	Range	Average
Beaches			
Winthrop Harbor	14	106 - 114	108
Zion	14	106 - 116	108
Illinois Beach State Park	14	104 - 116	108
Waukegan North	14	102 - 122	108
Waukegan Central	14	106 - 110	107
North Chicago	14	106 - 112	108
Lake Bluff	14	106 - 116	108
Lake Forest	14	104 - 116	107
Highwood	14	104 - 112	108
Highland Park-Park Avenue	14	104 - 116	108
Highland Park-Ravine Drive	14	106 - 114	108
Highland Park-Cary Avenue	13	104 - 130	109
Glencoe	14	106 - 110	107
Winnetka	14	106 - 110	107
Kenilworth	14	104 - 110	107
Wilmette	14	106 - 110	107
Evanston	14	106 - 110	107
Chicago-Touhy Avenue	14	106 - 110	107
Chicago-Bryn Mawr Avenue	14	106 - 110	107
Chicago-Montrose Avenue	14	106 - 108	107
Chicago-North Avenue	13	106 - 108	107
Chicago-12th Street	14	104 - 108	106
Chicago-31st Street	14	104 - 108	107
Chicago-63rd Street	14	104 - 108	106
Chicago-76th Street	14	104 - 108	107
Chicago-100th Street	14	106 - 108	107
	362	102 - 130	107
Water Plants			
Zion-Benton	24	104 - 116	108
Highland Park	24	102 - 116	107
Evanston	23	104 - 116	107
Chicago Central	24	102 - 112	107
Chicago South	24	106 - 120	108
	119	102 - 120	108

HEAVY METALS

During 1976, beach and water plant stations were monitored for 13 heavy metals. While many heavy metals have desirable or essential nutritional value in trace amounts, they are of concern at higher concentrations because of their toxic properties. Some heavy metals are a natural component of surface waters. The presence of heavy metals in higher concentrations is generally related to industrial and sewage discharges.

Measurable concentrations of cadmium, chromium (total), nickel, and selenium were not found in 182 beach samples (Table 18). Arsenic was found in concentrations of 0.002 and 0.003 mg/l at the Waukegan North beach and once at a concentration of 0.002 mg/l at the Cary Avenue beach in Highland Park. Barium was found at a concentration of 0.1 mg/l on 17 occasions at 12 beach stations. Measurable concentrations of boron were found at least once at all 26 beaches. A value of 0.2 mg/l was recorded once each from samples collected at Waukegan's North beach and the Cary Avenue beach in Highland Park. All other measurable boron values were 0.1 mg/l. Measurable concentrations of copper were found at least once at all of the beaches with the exception of Kenilworth. Concentrations ranged from <0.01 to 0.22 mg/l. Eleven of the 53 positive values exceeded the standard.

Measurable iron (total) concentrations were found in amounts ranging from <0.1 to 6.0 mg/l in 138 of the 182 samples analyzed. Concentrations exceeding the standard were found in 11 samples, and ten were from beaches in Lake County. Lead was found in eight samples from seven beaches in amounts ranging from <0.01 to 0.10 mg/l. Manganese concentrations ranging from <0.01 to 0.25 mg/l were found in 101 of 182 beach samples. Measurable concentrations of mercury were found in two samples from the adjacent Highland Park beaches at Ravine Drive and Cary Avenue. Values recorded were 0.0001 and 0.0003 mg/l, respectively. Zinc was found in three samples in amounts ranging from <0.1 mg/l at the Park Avenue and Cary Avenue beaches in Highland Park to 0.8 mg/l at Kenilworth.

Measurable concentrations of cadmium, chromium (total), nickel, and selenium were not present in 59 water plant samples (Table 19). Arsenic at 0.003 mg/l was recorded once from the Chicago Central water plant. Barium concentrations of 0.1 mg/l were recorded once from the Zion-Benton and Highland Park plants. Boron, in a concentration of 0.1 mg/l, was present in 16 samples from all five water plants. Forty-eight samples from the Zion-Benton, Highland Park, and the two Chicago water plants were analyzed for copper. Of these, 11 had a measurable concentration of 0.01 mg/l. At the Evanston water plant, only three copper values (<0.01, 0.01 and 0.02 mg/l) from October through December were evaluated for this report. In-plant contamination from copper water lines invalidated data for other samples at the Evanston plant.

Maximum iron (total) concentrations ranged from <0.1 to 1.2 mg/l, and the average of 59 samples was 0.1 mg/l. One excessive concentration of 1.2 mg/l was recorded from a Highland Park sample. Measurable concentrations of lead were recorded once each from the Zion-Benton, Highland Park, and Chicago Central water plants, and twice from the Chicago South plant. All values were 0.01 mg/l. Manganese concentrations of 0.01 mg/l were found once each at the Evanston and Chicago South plants, and concentrations of 0.01 mg/l and 0.04 mg/l were found at the Highland Park water plant. Mercury was found once at a concentration of 0.0001 mg/l in a sample from Highland Park. Zinc was found at a concentration of 0.1 mg/l in eight samples - all from Highland Park.

Table 18. Heavy metal concentrations recorded at Lake Michigan beaches during 1976. Concentrations are expressed in mg/l.

Heavy Metal	Standard	Samples Analyzed	Number of Samples Exceeding Standard	Number of Positive Samples	Range	Average
Arsenic	1.0	182	0	3	<0.001 - 0.003	<0.001
Barium	5.0	182	0	17	<0.1 - 0.1	<0.1
Boron	1.0	182	0	38	<0.1 - 0.2	<0.1
Cadmium	0.05	182	0	0	<0.01 - <0.01	<0.01
Chromium (Total)	1.05	182	0	0	<0.01 - <0.01	<0.01
Copper	0.02	182	11	53	<0.01 - 0.22	0.01
Iron (Total)	1.0	182	11	138	<0.1 - 6.0	0.3
Lead	0.1	182	0	8	<0.01 - 0.10	<0.01
Manganese	1.0	182	0	101	<0.01 - 0.25	0.02
Mercury	0.0005	182	0	2	<0.0001 - 0.0003	<0.0001
Nickel	1.0	182	0	0	<0.1 - <0.1	<0.1
Selenium	1.0	182	0	0	<0.01 - <0.01	<0.01
Zinc	1.0	182	0	3	<0.1 - 0.8	<0.1

Table 19. Heavy metal concentrations recorded at intakes of five municipal water filtration plants in 1976. Concentrations are expressed in mg/l.

Heavy Metal	Standard	Samples Analyzed	Number of Samples Exceeding Standard	Number of Positive Samples	Range	Average
Arsenic	0.01	59	0	1	<0.001 - 0.003	<0.001
Barium	1.0	59	0	2	<0.1 - 0.1	<0.01
Boron	1.0(a)	59	0	16	<0.1 - 0.1	<0.1
Cadmium	0.01	59	0	0	<0.01 - <0.01	<0.01
Chromium (Total)	1.05(a)	59	0	0	<0.01 - <0.01	<0.01
Copper	0.02(a)	51	0	13	<0.01 - 0.02	<0.01
Iron (Total)	0.3	59	1	32	<0.1 - 1.2	0.1
Lead	0.05	59	0	5	<0.01 - 0.01	<0.01
Manganese	0.05	59	0	4	<0.01 - 0.04	<0.01
Mercury	0.0005(a)	59	0	1	<0.0001 - 0.0001	<0.0001
Nickel	1.0(a)	59	0	0	<0.1 - <0.1	<0.1
Selenium	0.01	59	0	0	<0.01 - <0.01	<0.01
Zinc	1.0(a)	59	0	8	<0.1 - 0.1	<0.1

(a) General Standard

HARDNESS

Hard water forms scales in boilers, heaters, radiators, and pipes and is responsible for increased consumption of soap and detergents. In the aquatic environment hard waters have been shown to reduce the detrimental effects of toxic metals on aquatic life. Hardness over 100 mg/l becomes increasingly inconvenient as it results in a waste of soap. Good quality waters should not exceed 270 mg/l (McKee and Wolf, 1971).

Hardness levels at the beaches ranged from 130 to 280 mg/l. Averages by station ranged from 130 to 140 mg/l, and the average of all samples was 130 mg/l (Table 20).

Hardness levels at the water plants ranged from 130 to 140 mg/l, and the average of 119 samples was 130 mg/l.

COLOR

Color in water may result from the presence of various natural substances and industrial wastes. It is aesthetically undesirable and may pose problems for some industrial users. State standards for public water supplies limit the color of acceptable water to 15 units.

During the year, 362 beach samples were analyzed for color. All values were 2 units except for two values of 19 and 44 units, which were recorded from samples collected at the Cary Avenue beach in Highland Park (Table 21).

A total of 119 water plant samples were analyzed for color. All values were 2 units except for one sample from Highland Park which had a value of 4 units.

CHEMICAL OXYGEN DEMAND (COD)

Organic matter found in water undergoes various degrees of oxidation in the presence of strong, boiling acids. The chemical oxygen demand test measures, as oxygen equivalent, the oxidizable portion of the organic matter.

COD levels at the beaches ranged from 3 to 26 mg/l. Averages by station ranged from 11 to 13 mg/l, and the average of all samples was 12 mg/l (Table 22).

COD levels at the water plants ranged from 3 to 52 mg/l. Averages by plant ranged from 10 to 12 mg/l, and the average of 119 samples was 10 mg/l.

Table 20. Hardness levels recorded at Lake Michigan beaches and water plants in 1976. Concentrations are expressed in milligrams per liter (mg/l).

Sampling Location	Samples Analyzed	Range	Average
Beaches			
Winthrop Harbor	14	130 - 150	130
Zion	14	130 - 150	130
Illinois Beach State Park	14	130 - 150	130
Waukegan North	14	130 - 180	140
Waukegan Central	14	130 - 140	130
North Chicago	14	130 - 140	130
Lake Bluff	14	130 - 280	140
Lake Forest	14	130 - 140	130
Highwood	14	130 - 140	130
Highland Park-Park Avenue	14	130 - 140	130
Highland Park-Ravine Drive	14	130 - 140	130
Highland Park-Cary Avenue	13	130 - 160	130
Glencoe	14	130 - 140	130
Winnetka	14	130 - 140	130
Kenilworth	14	130 - 140	130
Wilmette	14	130 - 140	130
Evanston	14	130 - 140	130
Chicago-Touhy Avenue	14	130 - 140	130
Chicago-Bryn Mawr Avenue	14	130 - 130	130
Chicago-Montrose Avenue	14	130 - 140	130
Chicago-North Avenue	13	130 - 140	130
Chicago-12th Street	14	130 - 140	130
Chicago-31st Street	14	130 - 140	130
Chicago-63rd Street	14	130 - 140	130
Chicago-76th Street	14	130 - 140	130
Chicago-100th Street	14	130 - 140	130
	362	130 - 280	130
Water Plants			
Zion-Benton	24	130 - 140	130
Highland Park	24	130 - 140	130
Evanston	23	130 - 140	130
Chicago Central	24	130 - 140	130
Chicago South	24	130 - 140	130
	119	130 - 140	130

Table 21. Color levels at Lake Michigan beaches and water plants in 1976. Values are expressed in color units.

Sampling Location	Samples Analyzed	Range	Average
Beaches			
Winthrop Harbor	14	2 - 2	2
Zion	14	2 - 2	2
Illinois Beach State Park	14	2 - 2	2
Waukegan North	14	2 - 2	2
Waukegan Central	14	2 - 2	2
North Chicago	14	2 - 2	2
Lake Bluff	14	2 - 2	2
Lake Forest	14	2 - 2	2
Highwood	14	2 - 2	2
Highland Park-Park Avenue	14	2 - 2	2
Highland Park-Ravine Drive	14	2 - 2	2
Highland Park-Cary Avenue	13	2 - 44	7
Glencoe	14	2 - 2	2
Winnetka	14	2 - 2	2
Kenilworth	14	2 - 2	2
Wilmette	14	2 - 2	2
Evanston	14	2 - 2	2
Chicago-Touhy Avenue	14	2 - 2	2
Chicago-Bryn Mawr Avenue	14	2 - 2	2
Chicago-Montrose Avenue	14	2 - 2	2
Chicago-North Avenue	13	2 - 2	2
Chicago-12th Street	14	2 - 2	2
Chicago-31st Street	14	2 - 2	2
Chicago-63rd Street	14	2 - 2	2
Chicago-76th Street	14	2 - 2	2
Chicago-100th Street	14	2 - 2	2
	362	2 - 44	2
Water Plants			
Zion-Benton	24	2 - 2	2
Highland Park	24	2 - 4	2
Evanston	23	2 - 2	2
Chicago Central	24	2 - 2	2
Chicago South	24	2 - 2	2
	119	2 - 4	2

Table 22. Chemical oxygen demand (COD) levels recorded at Lake Michigan beaches and water plants in 1976. Values are expressed in milligrams per liter (mg/l).

Sampling Location	Samples Analyzed	Range	Average
Beaches			
Winthrop Harbor	14	5 - 18	12
Zion	14	4 - 21	11
Illinois Beach State Park	14	5 - 19	11
Waukegan North	14	3 - 18	11
Waukegan Central	14	5 - 18	11
North Chicago	14	4 - 19	11
Lake Bluff	14	4 - 17	11
Lake Forest	14	3 - 19	11
Highwood	14	3 - 21	12
Highland Park-Park Avenue	14	4 - 18	11
Highland Park-Ravine Drive	14	4 - 19	12
Highland Park-Cary Avenue	13	4 - 25	13
Glencoe	14	6 - 19	12
Winnetka	14	5 - 17	11
Kenilworth	14	5 - 26	13
Wilmette	14	5 - 19	12
Evanston	14	5 - 24	12
Chicago-Touhy Avenue	14	4 - 24	12
Chicago-Bryn Mawr Avenue	14	5 - 18	12
Chicago-Montrose Avenue	14	4 - 16	11
Chicago-North Avenue	13	4 - 20	12
Chicago-12th Street	14	4 - 20	12
Chicago-31st Street	14	5 - 20	12
Chicago-63rd Street	14	5 - 21	12
Chicago-76th Street	14	6 - 21	12
Chicago-100th Street	14	5 - 21	12
	362	3 - 26	12
Water Plants			
Zion-Benton	24	3 - 21	10
Highland Park	24	4 - 20	10
Evanston	23	4 - 52	12
Chicago Central	24	4 - 20	10
Chicago South	24	4 - 21	10
	119	3 - 52	10

SPECIAL SAMPLING

GENERAL INFORMATION

Monitoring for PCB's (polychlorinated biphenyls) and selected pesticides (heptachlor epoxide, dieldrin and total DDT) was continued in 1976. Water samples were collected at three stream stations tributary to Lake Michigan in Lake County, Illinois. The streams were Kellogg Creek, Pettibone Creek, and the Waukegan River. Two sewage treatment plant effluents were monitored at the Waukegan and North Chicago plants of the North Shore Sanitary District. Fish samples were not collected or analyzed in 1976 in order to eliminate duplication of effort by other agencies and also due to budgetary considerations. Federal capabilities for fish sample collection and analysis are considerably greater than the State of Illinois and are summarized in this report.

On November 22, 1974, Chapter 6 of the Water Pollution Regulations for Public Water Supplies was adopted by the Illinois Pollution Control Board. These regulations set forth maximum allowable limits for finished water (after treatment) for a number of parameters including several pesticides and herbicides. The concentrations provided in the regulation are for maximum allowable twelve month average concentrations for finished water (after treatment).

Parameter	Maximum Concentration mg/l
Aldrin	0.001
Chlordane	0.003
DDT	0.05
Dieldrin	0.001
Endrin	0.0005
Heptachlor	0.0001
Heptachlor Epoxide	0.0001
Lindane	0.005
Methoxychlor	0.1
Toxaphene	0.005
Parathion	0.1
2,4-D	0.02
2, 4, 5-TP or Silvex	0.01

On June 26, 1975 the Lake Michigan Toxic Substances Committee recommended, "a national ban on all domestic and imported PCB's destined for use other than in transformers and capacitors and that the critical or essential use of PCB's in transformers and capacitors be immediately and critically reviewed in light of current potential replacement products."

Table 23. Pesticides and PCB's found in effluents of sewage treatment plants tributary to Lake Michigan in 1976. Concentrations are expressed as parts per trillion (ppt).

Location	Date Collected	Heptachlor Epoxide	Dieldrin	Total DDT (a)	Total (b) PCB's
NSSD Waukegan STP	01-06-76	21.0	22.0	57.0	120.0
NSSD Waukegan STP	02-10-76	4.0	12.0	<110.0 (c)	100.0
NSSD Waukegan STP	03-09-76	3.0	32.0	36.0	100.0
NSSD Waukegan STP	04-07-76	17.0	31.0	<104.0 (c)	460.0
NSSD Waukegan STP	05-19-76	8.0	24.0	24.0	300.0
NSSD Waukegan STP	07-07-76	3.0	6.0	(c)	120.0
NSSD Waukegan STP	08-10-76	2.0	7.0	< 10.0	<100.0
NSSD Waukegan STP	09-08-76	2.0	3.0	51.0	<100.0
NSSD Waukegan STP	10-06-76	<2.0	5.0	12.0	1030.0
NSSD No. Chicago STP (d)	01-06-76	2.0	13.0	<10.0	<100.0
NSSD No. Chicago STP	02-10-76	7.0	< 2.0	40.0	170.0
NSSD No. Chicago STP	03-09-76	<2.0	34.0	<10.0	<100.0
NSSD No. Chicago STP	04-07-76	5.0	18.0	30.0	<100.0

(a) o,p' and p,p' isomers of DDT ,DDE,and DDD

(b) Aroclor 1242 and 1254

(c) Interference

(d) effluent diverted away from Lake Michigan April, 1976

On November 19-21, 1975 a National Conference on Polychlorinated Biphenyls was held in Chicago. The objectives of the conference were to: clarify the problems associated with the manufacture, use and disposal of PCB's; assess the effectiveness of steps taken to reduce the problems associated with PCB's; clarify the feasibility and complications of steps to reduce the problems associated with PCB's.

On November 26, 1975 the Illinois Pollution Control Board referred a petition requesting informational hearings on PCB's to the Illinois Institute for Environmental Quality. The Board requested that the Institute monitor the Federal effort to control PCB's and report back to the Board within 6 months. If feasible the Institute is also to propose a control strategy to the Board.

On October 12, 1976 the Toxic Substances Control Act was passed. The law provides for the regulation of the manufacture, processing, distribution, disposal, and adequate labeling of toxic substances that may have an effect on the environment or public health. The Act bans PCB's within two years.

RESULTS OF MONITORING
PESTICIDES AND POLYCHLORINATED BIPHENYLS

Water Samples

A total of forty-four water samples were collected at Kellogg Creek, the Waukegan River, Pettibone Creek, and the North Shore Sanitary District sewage treatment plants at North Chicago and Waukegan (Tables 23 and 24). A maximum concentration of heptachlor epoxide was found at the NSSD Waukegan sewage treatment plant (21.0 ppt) while the NSSD North Chicago plant registered the maximum for dieldrin (34.0 ppt). Concentrations of total PCB's were most often below 100.0 ppt at both the streams and sewage treatment plants with several exceptions. Pettibone Creek registered values of 470.0 ppt and 790.0 ppt in February and July respectively. The North Shore Sanitary District plant at Waukegan registered high values of 460.0 ppt and 1030.0 ppt during the year. Total DDT concentrations were less than 50 ppt in 37 of 44 samples at both the streams and sewage plants.

There was no indication of any upward or downward trend in the concentration of any of the pesticides and PCB's monitored, contrary to some earlier indications.

Interfering compounds continue to cause analytical problems, which make quantification of some samples impossible at low detection limits. In some cases concentrations are being reported as less than a certain value because of the interfering compounds.

Table 24. Pesticides and PCB's found in waters from Illinois streams tributary to Lake Michigan in 1976. Concentrations are expressed in parts per trillion, (ppt).

Location	Date Collected	Heptachlor Epoxide	Dieldrin	Total DDT (a)	Total (b) PCB's
Kellogg Creek	03-09-76	5.0	19.0	16.0	100.0
Kellogg Creek	04-07-76	<90.0 (c)	12.0	<69.0 (c)	<100.0
Kellogg Creek	05-19-76	14.0	19.0	<10.0	100.0
Kellogg Creek	06-08-76	3.0	9.0	10.0	<100.0
Kellogg Creek	07-07-76	2.0	7.0	<10.0	<100.0
Kellogg Creek	08-10-76	2.0	4.0	<10.0	<100.0
Kellogg Creek	09-08-76	2.0	5.0	16.0	<100.0
Kellogg Creek	10-06-76	4.0	7.0	42.0	140.0
Kellogg Creek	11-08-76	2.0	3.0	<10.0	<100.0
Waukegan River	01-06-76	3.0	4.0	<10.0	<100.0
Waukegan River	02-10-76	2.0	16.0	22.0	160.0
Waukegan River	03-09-76	6.0	14.0	11.0	120.0
Waukegan River	04-07-76	6.0	10.0	10.0	<100.0
Waukegan River	05-19-76	13.0	18.0	30.0	130.0
Waukegan River	06-08-76	9.0	6.0	<10.0	<100.0
Waukegan River	07-07-76	< 2.0	5.0	27.0	<100.0
Waukegan River	08-10-76	3.0	5.0	<10.0	<100.0
Waukegan River	09-08-76	2.0	4.0	<10.0	110.0
Waukegan River	10-06-76	2.0	4.0	<103.0 (c)	110.0
Waukegan River	11-08-76	2.0	6.0	12.0	<100.0

(a) o,p' and p,p' isomers of DDT ,DDE,and DDD

(b) Aroclor 1242 and 1254

(c) Interference

(Continued)

Table 24. Pesticides and PCB's found in waters from Illinois streams tributary to Lake Michigan in 1976. Concentrations are expressed in parts per trillion, (ppt).

Location	Date Collected	Heptachlor Epoxide	Dieldrin	Total DDT (a)	Total (b) PCB's
Pettibone Creek	01-06-76	5.0	7.0	10.0	<100.0
Pettibone Creek	02-10-76	2.0	25.0	14.0	470.0
Pettibone Creek	03-09-76	5.0	6.0	27.0	<100.0
Pettibone Creek	04-08-76	2.0	18.0	10.0	<100.0
Pettibone Creek	05-19-76	5.0	15.0	26.0	110.0
Pettibone Creek	06-08-76	2.0	11.0	33.0	100.0
Pettibone Creek	07-07-76	3.0	2.0	22.0	790.0
Pettibone Creek	08-10-76	2.0	2.0	37.0	<100.0
Pettibone Creek	09-08-76	3.0	3.0	10.0	<100.0
Pettibone Creek	10-19-76	2.0	4.0	33.0	130.0
Pettibone Creek	11-08-76	2.0	2.0	<10.0	<100.0

(a) o,p' and p,p' isomers of DDT ,DDE,and DDD

(b) Aroclor 1242 and 1254

Fish Samples

In 1976 fish samples from Lake Michigan were not analyzed by the Illinois Environmental Protection Agency. A larger data base is available from the U. S. Fish and Wildlife Service which has specialized in collecting fisheries data for Lake Michigan on a large scale for a number of years.

The Fish and Wildlife Service has statistical data on three species of fish which include the bloater, coho salmon, and lake trout. Data on levels of DDT and dieldrin have been collected since 1969 and on PCB's since 1972.

Results for 1975 show that PCB levels in the coho salmon and lake trout remain at unacceptably high concentrations well in excess of the U. S. Food and Drug Administration's standard of 5 ppm (Table 25). Only the bloater is at levels near 5 ppm. Coho salmon have approximately twice the acceptable concentration of PCB's while lake trout have approximately four times the FDA Standard.

Concentrations of DDT have dropped considerably in all three species. In spite of the reduction in concentrations the lake trout remains in excess of the 5 ppm USFDA tolerance limit. Concentrations of dieldrin remain below the USFDA standard of 0.3 ppm for coho salmon but near the 0.3 ppm level for bloaters and lake trout.

Table 25. Concentrations of pesticides and PCB's in fall collections of Lake Michigan bloaters and lake trout off Saugatuck, Michigan, and coho salmon from between Ludington and Frankfort, Michigan (USFWS, Great Lakes Fishery Laboratory data).

Species and Year	Number of Fish	Average length (mm)	Total DDT (ppm)1/	Dieldrin (ppm)1/	Total PCB's (ppm)1/
Bloaters					
1969	120	270	9.94 (0.33)	0.27 (0.01)	-
1970	28	263	9.87 (1.44)	0.19 (0.02)	-
1971	60 2/	264	6.24 (1.13)	0.27 (0.06)	-
1972	120 3/	255	4.33 (0.48)	0.18 (0.03)	5.66 (0.95)
1973	160 3/	250	2.09 (0.26)	0.28 (0.02)	5.24 (0.37)
1974	110 3/	257	1.33 (0.14)	0.28 (0.03)	5.57 (0.31)
1975	170 3/	249	1.27 (0.20)	0.39 (0.03)	4.54 (0.36)
Coho Salmon					
1969	11	621	11.82 (2.69)	0.21 (0.02)	-
1970	13	651	14.03 (1.29)	0.12 (0.02)	-
1971	15	674	9.85 (1.41)	0.11 (0.01)	-
1972	10	693	7.17 (1.09)	0.13 (0.04)	10.93 (2.12)
1973	29	620	4.48 (0.34)	0.09 (0.01)	12.17 (0.77)
1974	30	665	3.82 (0.34)	0.10 (0.01)	10.45 (0.92)
1975	30	645	3.25 (0.20)	0.10 (0.01)	10.77 (0.59)
Lake trout					
1970	18	613	19.19 (3.27)	0.27 (0.05)	-
1971	20	579	13.00 (1.76)	0.20 (0.03)	-
1972	9	648	11.31 (3.26)	0.20 (0.06)	12.86 (4.75)
1973	30	602	9.96 (1.36)	0.27 (0.03)	18.93 (2.08)
1974	30	616	8.42 (1.74)	0.30 (0.03)	22.91 (3.73)
1975	29	613	7.50 (1.25)	0.35 (0.03)	22.28 (2.90)

1/Concentration in whole fish, wet weight with 95% confidence interval in parentheses.

2/Composite samples, 5 fish/sample.

3/Composite samples, 10 fish/sample.

ILLINOIS DISCHARGES AND POLLUTIONAL SOURCES

Abbott Laboratories (Manufacturer of pharmaceutical products)

In September of 1976 Abbott diverted its wastewater discharge from Lake Michigan to the North Shore Sanitary District sewage treatment plant in Gurnee. A cooling water discharge continues to be discharged to Lake Michigan.

Commonwealth Edison Company, Waukegan Station (fossil-fueled electric generating station)

This plant has been in operation since 1927. It utilizes Lake Michigan water for condenser cooling and discharges heated cooling water back to the lake. The maximum temperature rise through the condensers is 12°F. This station also has an ash pond discharge to the lake. The discharges are in general compliance with the standards.

Commonwealth Edison Company, Zion Station (nuclear-fueled electric generating station)

Initial plant operation began in 1972. This station utilizes Lake Michigan water for condenser cooling and discharges heated cooling water back to the lake. The maximum temperature rise through the condensers is 20°F.

Fansteel, Incorporated (producer of corrosion-resistant metals used for electrical and chemical applications)

Fansteel's process wastewater discharge to Lake Michigan via Pettibone Creek was eliminated in 1974. Fansteel was cited for several discharge violations in 1975. In-plant inspections resulted in the formulation of a compliance plan which is now being implemented. Cooling water continues to be discharged to Pettibone Creek.

Johnson Outboards, Division of Outboard Marine Corporation (manufacturer of outboard motors)

Johnson Outboards has several discharges of process wastes and cooling water. One discharge enters Lake Michigan via a ditch located several hundred yards north of Waukegan's North Beach, while the others discharge into Lake Michigan via Waukegan Harbor. In-plant treatment consists of oil separation and removal.

During 1975 and 1976 polychlorinated biphenyls (PCB's) were found in several discharges. The PCB's had been previously used as a hydraulic fluid in die cast machines. Johnson currently has a program underway to eliminate the discharge of PCB's. Studies are also underway to determine the degree of PCB contamination in Waukegan Harbor and the ditch bottom sediments.

United States Steel Corporation, Waukegan Works (producer of stainless and carbon steel wire and springs)

Litigation concerning compliance with effluent standards was concluded in 1975. A compliance schedule has been established whereby process contaminated wastes will be diverted, following pretreatment, to the North Shore Sanitary District's Gurnee sewage treatment plant by July, 1977. After this date, only noncontact cooling water will be discharged to the lake.

United States Steel, South Works (steel smelting plant)

A closed cycle system for process contaminated wastes was completed in December, 1975. Only noncontact cooling water is discharged from this plant to Lake Michigan and the Calumet River.

North Shore Sanitary District (N.S.S.D.)

The N.S.S.D. North Chicago sewage treatment plant effluent was diverted out of Lake Michigan to the Gurnee sewage treatment plant (DesPlaines River watershed) in April, 1976. The remaining North Shore Sanitary District discharges to Lake Michigan are from the N.S.S.D. Waukegan sewage treatment plant and a Lake Bluff wet weather discharge. The Waukegan discharge is to be diverted to the DesPlaines River in 1977. In the interim, phosphorus reduction facilities are in operation at the Waukegan plant. The Lake Forest wet weather discharge is to be eliminated in 1977.

Federal Installations

The Great Lakes Naval Training Center diverted its wastewater discharge from Lake Michigan to the North Shore Sanitary District's Gurnee sewage treatment plant in July, 1976.

The sewage treatment plant at Fort Sheridan is currently operating at less than the design capacity due to the transferral of Fifth Army Headquarters. Connection to the North Shore Sanitary District's Gurnee plant is expected in 1977. Chemical addition facilities for phosphorus reduction continue to be operational.

WATER PLANT WASTES

The remaining municipal water filtration plants, which have not yet eliminated filter backwash and settling basin discharges to Lake Michigan, are preparing plans to either divert the discharges to municipal sewage treatment plants or provide on-site treatment sufficient to meet the standards. National Pollutant Discharge Elimination System (NPDES) permits issued to these municipalities require compliance by July 1, 1977.

MSDGC OVERFLOWS

Sewage from all of the Lake Shore municipalities in Cook County (Glencoe to Chicago) is treated by sewage treatment facilities of the Metropolitan Sanitary District of Greater Chicago. The treated effluents are discharged to a system of waterways that are tributary to the DesPlaines River. Historically, the Chicago River and the Calumet River were tributaries of Lake Michigan. However, with the repeated outbreaks of waterborne disease epidemics experienced by Chicago in the late 1800's caused by the contamination of the City's drinking water by the flow of polluted river water into the lake, the District constructed a canal system which reversed the direction of flow, diverting flows from Lake Michigan to the Mississippi River via the DesPlaines and Illinois Rivers.

Dilution of these waste flows is provided by diversion of water from Lake Michigan. Three controlling locks, located at Wilmette, the mouth of the Chicago River and the O'Brien Lock on the Calumet River, serve to regulate the flow of lake water into the waterways while preventing backflows into Lake Michigan.

Water levels in the waterways are regulated by the District's lock and dam facility at Lockport, Illinois. Whenever heavy rains are predicted the Lockport dam is opened, lowering the water levels to prevent flood damage. However, during severe rains, the capacity of the District to drain away runoff may be exceeded and, to relieve the threat of flooded basements, one or more of the three locks may be opened causing polluted river water to reach the lake.

The following list indicates the dates on which reverse flows have occurred over the past nine years:

1976	April 25
1975	April 18, August 22
1974	None
1973	None
1972	June 14, August 26, September 17
1971	None
1970	None
1969	October 10
1968	August 16

The District is in the initial phases of a long-term construction program to control flooding and backflows. The Tunnel and Reservoir Plan adopted by the District consists of a system of conveyance tunnels and storage reservoirs to transport and store combined sewage flows during periods of heavy rainfall. Subsequently, these flows, which are presently discharged to the waterways, would be pumped to the District's facilities for treatment.

August 1976 "Swimmers Itch Outbreak"

On August 10th Wilmette, Kenilworth, and Glencoe public beaches were closed after complaints of itching by swimmers. Water samples sent to the State Health Department Laboratory for analysis did not confirm the presence of the "swimmers itch" parasite. The true "swimmers itch" parasite is common in inland weedy lakes but is uncommon in Lake Michigan. Some species of algae have been known to cause an itching and symptoms similar to the "swimmers itch" although this too is uncommon and has not been confirmed in the Illinois Waters of Lake Michigan in recent years.

September 1976 Fish Kill

Between September 23 and 28 approximately 100 dead chinook salmon ranging in size from 4 to 25 pounds were found in Waukegan Harbor. Investigations by the Illinois Department of Conservation and this Agency were unable to determine the exact cause of death. Water samples indicated ammonia levels in excess of the Lake Michigan standard but below levels lethal to these fish. Water quality at the time of the kill was not known because water samples were not collected until some time after the kill.

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